

## EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	288	717/130.ccls.	USPAT	OR	OFF	2007/08/04 14:22
L2	337	717/131.ccls.	USPAT	OR	OFF	2007/08/04 14:22
L3	384	717/140.ccls.	USPAT	OR	OFF	2007/08/04 14:22
L4	82	717/145.ccls.	USPAT	OR	OFF	2007/08/04 14:23
L5	340	717/151.ccls.	USPAT	OR	OFF	2007/08/04 14:23
L6	216	717/158.ccls.	USPAT	OR	OFF	2007/08/04 14:23
L7	11	717/158.ccls. and (static\$4 ) and (runtime or dynamic\$4 or "run-time" ) and (profil\$3 or instrument\$5 ) and (analysis or characterization or statistic\$4 or heuristic\$4 or metadata or threshold or feedback or probabilit\$3 ) and (hint or directive) and (state or status or snapshot) and (time or profitab\$5 or optimal\$2 or expensive ) and (change or modification or delta or prior or subsequent\$2 ) and (optimiz\$5 or optimis\$5 ) and (compil\$5 or recompil\$5 )	USPAT	OR	ON	2007/08/04 16:02
L8	343	(static\$4 ) and (runtime or dynamic\$4 or "run-time" ) and (profil\$3 or instrument\$5 ) and (analysis or characterization or statistic\$4 or heuristic\$4 or metadata or threshold or feedback or probabilit\$3 ) and (hint or directive) and (state or status or snapshot) and (time or profitab\$5 or optimal\$2 or expensive ) and (change or modification or delta or prior or subsequent\$2 ) and (optimiz\$5 or optimis\$5 ) and (compil\$5 or recompil\$5 )	USPAT	OR	ON	2007/08/04 14:32

## EAST Search History

L9	65	717/???.ccls. and (static\$4 ) and (runtime or dynamic\$4 or "run-time" ) and (profil\$3 or instrument\$5 ) and (analysis or characterization or statistic\$4 or heuristic\$4 or metadata or threshold or feedback or probabilit\$3 ) and (hint or directive) and (state or status or snapshot) and (time or profitab\$5 or optimal\$2 or expensive ) and (change or modification or delta or prior or subsequent\$2 ) and (optimiz\$5 or optimis\$5 ) and (compil\$5 or recompil\$5 )	USPAT	OR	ON	2007/08/04 14:32
L10	5	"statistical profile" same compil\$5	USPAT	OR	ON	2007/08/04 14:34
L11	13	717/158.ccls. and (static\$4 ) and (runtime or dynamic\$4 or "run-time" ) and (profil\$3 or instrument\$5 ) and (analysis or characterization or statistic\$4 or heuristic\$4 or metadata or threshold or feedback or probabilit\$3 ) and (hint or directive) and (state or status or snapshot) and (time or profitab\$5 or optimal\$2 or expensive ) and (change or modification or delta or prior or subsequent\$2 ) and (optimiz\$5 or optimis\$5 ) and (compil\$5 or recompil\$5 )	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/08/04 16:04
L12	4	("6434714" "6986130" ).pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2007/08/04 16:05


[Subscribe \(Full Service\)](#) [Register \(Limited Service, Free\)](#) [Login](#)
 The ACM Digital Library  The Guide

**THE GUIDE TO COMPUTING LITERATURE**
[Feedback](#) [Report a problem](#) [Satisfaction survey](#)

## Vortex: an optimizing compiler for object-oriented languages

**Full text** [PDF \(2.45 MB\)](#)

**Source** [Conference on Object Oriented Programming Systems Languages and Applications archive](#)  
[Proceedings of the 11th ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications table of contents](#)  
 San Jose, California, United States  
 Pages: 83 - 100  
 Year of Publication: 1996  
 ISSN:0362-1340  
[Also published in ...](#)

**Authors** [Jeffrey Dean](#) Department of Computer Science and Engineering, University of Washington, Box 352350, Seattle, Washington  
[Greg DeFouw](#) Department of Computer Science and Engineering, University of Washington, Box 352350, Seattle, Washington  
[David Grove](#) Department of Computer Science and Engineering, University of Washington, Box 352350, Seattle, Washington  
[Vassily Litvinov](#) Department of Computer Science and Engineering, University of Washington, Box 352350, Seattle, Washington  
[Craig Chambers](#) Department of Computer Science and Engineering, University of Washington, Box 352350, Seattle, Washington

**Sponsor** [SIGPLAN: ACM Special Interest Group on Programming Languages](#)

**Publisher** ACM Press New York, NY, USA

**Additional Information:** [abstract](#) [references](#) [cited by](#) [index terms](#) [collaborative colleagues](#) [peer to peer](#)

**Tools and Actions:** [Find similar Articles](#) [Review this Article](#)  
[Save this Article to a Binder](#) [Display Formats: BibTeX](#) [EndNote](#) [ACM Ref](#)

**DOI Bookmark:** Use this link to bookmark this Article: <http://doi.acm.org/10.1145/236337.236344>  
[What is a DOI?](#)

### ↑ ABSTRACT

Previously, techniques such as class hierarchy analysis and profile-guided receiver-class prediction have been demonstrated to greatly improve the performance of applications written in pure object-oriented languages, but the degree to which these results are transferable to applications written in hybrid languages has been unclear. In part to answer this question, we have developed the Vortex compiler infrastructure, a language-independent optimizing compiler for object-oriented languages, with front-ends for Cecil, C++, Java, and Modula-3. In this paper, we describe the Vortex compiler's intermediate language, internal structure, and optimization suite, and then we report the results of experiments assessing the effectiveness of different combinations of optimizations on sizable applications across these four languages. We characterize the benchmark programs in terms of a collection of static and dynamic metrics, intended to quantify aspects of the "object-orientedness" of a program.

### ↑ REFERENCES

Note: OCR errors may be found in this Reference List extracted from the full text article. ACM has opted to expose the complete List rather than only correct and linked references.

 Agesen & Hözle 95 [Ole Agesen , Urs Hözle, Type feedback vs. concrete type inference: a comparison of optimization techniques for object-oriented languages, Proceedings of the tenth annual conference on Object-oriented programming systems, languages, and applications, p.91-107, October 15-19, 1995, Austin, Texas, United States \[doi>10.1145/217839.217847\]](#)

Agesen & Hözle 96 [Urs Hözle , Ole Agesen, Dynamic versus static optimization techniques for object-oriented languages, Theory and Practice of Object Systems, v.1 n.3, p.167-188, Fall 1995](#)

Agesen 95 [Ole Agesen, The Cartesian Product Algorithm: Simple and Precise Type Inference Of Parametric Polymorphism, Proceedings of the 9th European Conference on Object-Oriented Programming, p.2-26, August 07-11, 1995](#)

Aho et al. 86 [Alfred V. Aho , Ravi Sethi , Jeffrey D. Ullman, Compilers: principles, techniques, and tools, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1986](#)

Aigner & Hözle 96 [Gerald Aigner , Urs Hözle, Eliminating Virtual Function Calls in C++ Programs, Proceedings of the 10th European Conference on Object-Oriented Programming, p.142-166, July 08-12, 1996](#)

 AK et al. 89 [Hassan Aït-Kaci , Robert Boyer , Patrick Lincoln , Roger Nasr, Efficient implementation of lattice operations, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.11 n.1, p.115-146, Jan. 1989 \[doi>10.1145/59287.59293\]](#)

 Bacon & Sweeney 96 [David F. Bacon , Peter F. Sweeney, Fast static analysis of C++ virtual function calls, Proceedings of the 11th ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications, p.324-341, October 06-10, 1996, San Jose, California, United States \[doi>10.1145/236338.236371\]](#)

 Bieman & Zhao 95 [James M. Bieman , Josephine Xia Zhao, Reuse through inheritance: a quantitative study of C++ software, Proceedings of the 1995 Symposium on Software reusability, p.47-52, April 29-30, 1995, Seattle, Washington, United States \[doi>10.1145/223427.211794\]](#)

 Bobrow et al. 88 [Daniel G. Bobrow , Linda G. DeMichiel , Richard P. Gabriel , Sonya E. Keene , Gregor Kiczales , David A. Moon, Common Lisp Object System specification, ACM SIGPLAN Notices, v.23 n.SI, p.1-142, September 1988 \[doi>10.1145/885631.885632\]](#)

 Calder & Grunwald 94 [Brad Calder , Dirk Grunwald, Reducing indirect function call overhead in C++ programs, Proceedings of the 21st ACM SIGPLAN-SIGACT symposium on Principles of programming languages, p.397-408, January 16-19, 1994, Portland, Oregon, United States \[doi>10.1145/174675.177973\]](#)

 Chambers & Ungar 89 [C. Chambers , D. Ungar, Customization: optimizing compiler technology for SELF, a dynamically-typed object-oriented programming language, ACM SIGPLAN Notices, v.24 n.7, p.146-160, July 1989 \[doi>10.1145/73141.74831\]](#)

 Chambers & Ungar 90 [Craig Chambers , David Ungar, Interactive type analysis and extended message splitting; optimizing dynamically-typed object-oriented programs, ACM SIGPLAN Notices, v.25 n.6, p.150-164, Jun. 1990 \[doi>10.1145/93542.93562\]](#)

Chambers 92 [Craig Chambers, Object-Oriented Multi-Methods in Cecil, Proceedings of the European Conference on Object-Oriented Programming, p.33-56, June 29-July 03, 1992](#)

Chambers 93 Craig Chambers. The Cecil Language: Specification and Rationale. Technical Report TR-93-03-05, Department of Computer Science and Engineering. University of Washington, March 1993.

 Chambers et al. 95 [Craig Chambers , Jeffrey Dean , David Grove, A framework for selective recompilation in the presence of complex intermodule dependencies, Proceedings of the 17th international conference on Software engineering, p.221-230, April 24-28, 1995, Seattle, Washington, United States](#) [doi>[10.1145/225014.225035](https://doi.org/10.1145/225014.225035)]

Chambers et al. 96 Craig Chambers, Jeffrey Dean, and David Grove. Whole-Program Optimization of Object-Oriented Languages. Technical Report TR-96-06-02, Department of Computer Science and Engineering. University of Washington, June 1996.

Chien 93 [Andrew A. Chien, Concurrent aggregates: supporting modularity in massively parallel programs, MIT Press, Cambridge, MA, 1993](#)

 Click & Cooper 95 [Cliff Click , Keith D. Cooper, Combining analyses, combining optimizations, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.17 n.2, p.181-196, March 1995](#) [doi>[10.1145/201059.201061](https://doi.org/10.1145/201059.201061)]

 Dean et al. 95a [Jeffrey Dean , Craig Chambers , David Grove, Selective specialization for object-oriented languages, ACM SIGPLAN Notices, v.30 n.6, p.93-102, June 1995](#) [doi>[10.1145/223428.207119](https://doi.org/10.1145/223428.207119)]

Dean et al. 95b [Jeffrey Dean , David Grove , Craig Chambers, Optimization of Object-Oriented Programs Using Static Class Hierarchy Analysis, Proceedings of the 9th European Conference on Object-Oriented Programming, p.77-101, August 07-11, 1995](#)

 Deutsch & Schiffman 84 [L. Peter Deutsch , Allan M. Schiffman, Efficient implementation of the smalltalk-80 system, Proceedings of the 11th ACM SIGACT-SIGPLAN symposium on Principles of programming languages, p.297-302, January 15-18, 1984, Salt Lake City, Utah, United States](#) [doi>[10.1145/800017.800542](https://doi.org/10.1145/800017.800542)]

 Diwan et al. 96 [Amer Diwan , J. Eliot B. Moss , Kathryn S. McKinley, Simple and effective analysis of statically-typed object-oriented programs, Proceedings of the 11th ACM SIGPLAN conference on Object-oriented programming, systems, languages, and applications, p.292-305, October 06-10, 1996, San Jose, California, United States](#) [doi>[10.1145/236337.236367](https://doi.org/10.1145/236337.236367)]

EDG C++ Front End 2.28. Provided by Edison Design Group, Inc. <http://www.edg.com>.

 Fernandez 95 [Mary F. Fernández, Simple and effective link-time optimization of Modula-3 programs, ACM SIGPLAN Notices, v.30 n.6, p.103-115, June 1995](#) [doi>[10.1145/223428.207121](https://doi.org/10.1145/223428.207121)]

Goldberg & Robson 83 [Adele Goldberg , David Robson, Smalltalk-80: the language and its implementation, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1983](#)

Gosling et al. 96 [James Gosling , Bill Joy , Guy L. Steele, The Java Language Specification, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1996](#)

 Grove et al. 95 [David Grove , Jeffrey Dean , Charles Garrett , Craig Chambers, Profile-guided receiver class prediction, Proceedings of the tenth annual conference on Object-oriented programming systems, languages, and applications, p.108-123, October 15-19, 1995, Austin, Texas, United States](#) [doi>[10.1145/217838.217848](https://doi.org/10.1145/217838.217848)]

 Hözle & Ungar 94 Urs Hözle , David Ungar, Optimizing dynamically-dispatched calls with run-time type feedback, Proceedings of the ACM SIGPLAN 1994 conference on Programming language design and implementation, p.326-336, June 20-24, 1994, Orlando, Florida, United States [doi>[10.1145/773473.178478](https://doi.org/10.1145/773473.178478)]

Hözle et al. 91 Urs Hözle , Craig Chambers , David Ungar, Optimizing Dynamically-Typed Object-Oriented Languages With Polymorphic Inline Caches, Proceedings of the European Conference on Object-Oriented Programming, p.21-38, July 15-19, 1991

JDK Java Development Kit. Sun Microsystems Inc. <http://java.sun.com/>.

 Johnson 88 Ralph E. Johnson , Justin O. Graver , Laurance W. Zurawski, TS: an optimizing compiler for smalltalk, Conference proceedings on Object-oriented programming systems, languages and applications, p.18-26, September 25-30, 1988, San Diego, California, United States [doi>[10.1145/62084.62086](https://doi.org/10.1145/62084.62086)]

Lea 90 Doug Lea. Customization in C++. In Proceedings of the 1990 Usenix C++ Conference, San Francisco, CA, April 1990.

Nelson 91 Greg Nelson, Systems programming with Modula-3, Prentice-Hall, Inc., Upper Saddle River, NJ, 1991

Pande & Ryder 94 Hemant D. Pande and Barbara G. Ryder. Static Type Determination for C++. In Proceedings of Sixth USENIX C+ + Technical Conference, 1994.

 Plevyak & Chien 94 John Plevyak , Andrew A. Chien, Precise concrete type inference for object-oriented languages, Proceedings of the ninth annual conference on Object-oriented programming systems, language, and applications, p.324-340, October 23-28, 1994, Portland, Oregon, United States [doi>[10.1145/191081.191130](https://doi.org/10.1145/191081.191130)]

Schaffert et al. 85 Craig Schaffert, Topher Cooper, and Carrie Wilpolt. Trellis Object-Based Environment, Language Reference Manual. Technical Report DEC-TR-372, Digital Equipment Corporation, November 1985.

 Shao & Appel 95 Zhong Shao , Andrew W. Appel, A type-based compiler for standard ML, ACM SIGPLAN Notices, v.30 n.6, p.116-129, June 1995 [doi>[10.1145/223428.207123](https://doi.org/10.1145/223428.207123)]

SRC DEC SRC Modula-3 Implementation. Digital Equipment Corporation Systems Research Center. <http://www.research.digital.com/SRC/modula-3/html/home.html>.

Stroustrup 87 Bjarne Stroustrup. Multiple Inheritance for C++. In In Proceedings of the European Unix Users Group Conference '87, pages 189-207, Helsinki, Finland, May 1987.

Stroustrup 91 Bjarne Stroustrup, The C++ programming language (2nd ed.), Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1991

 Tarditi et al. 96 D. Tarditi , G. Morrisett , P. Cheng , C. Stone , R. Harper , P. Lee, TIL: a type-directed optimizing compiler for ML, ACM SIGPLAN Notices, v.31 n.5, p.181-192, May 1996 [doi>[10.1145/249069.231414](https://doi.org/10.1145/249069.231414)]

 Tjiang & Hennessy 92 Steven W. K. Tjiang , John L. Hennessy, Sharlit—a tool for building optimizers, ACM SIGPLAN Notices, v.27 n.7, p.82-93, July 1992 [doi>[10.1145/143103.143120](https://doi.org/10.1145/143103.143120)]

 Ungar & Smith 87 David Ungar , Randall B. Smith, Self: The power of simplicity, Conference proceedings on Object-oriented programming systems, languages and

applications, p.227-242, October 04-08, 1987, Orlando, Florida, United States  
[doi>[10.1145/38765.38828](https://doi.org/10.1145/38765.38828)]

↑ CITED BY 44

- ◆ Jan Vitek , R. Nigel Horspool , Andreas Krall, Efficient type inclusion tests, ACM SIGPLAN Notices, v.32 n.10, p.142-157, Oct. 1997
- ◆ Sorin Lerner , Todd Millstein , Craig Chambers, Automatically proving the correctness of compiler optimizations, ACM SIGPLAN Notices, v.38 n.5, May 2003
- S. Baskiar, Efficient execution of pure object-oriented programs by follow-up compilation, Computing, v.69 n.4, p.273-289, December 2002

Jongwook Woo , Isabelle Attali , Denis Caromel , Jean-Luc Gaudiot , Andrew L. Wendelborn, Alias analysis on type inference for class hierarchy in Java, Australian Computer Science Communications, v.23 n.1, p.206-214, January-February 2001

- ◆ Tao Li , Ravi Bhargava , Lizy Kurian John, Adapting branch-target buffer to improve the target predictability of java code, ACM Transactions on Architecture and Code Optimization (TACO), v.2 n.2, p.109-130, June 2005

- ◆ Norman Ramsey , Mary F. Fernández, Specifying representations of machine instructions, ACM Transactions on Programming Languages and Systems (TOPLAS), v.19 n.3, p.492-524, May 1997
- ◆ Peter F. Sweeney , Frank Tip, A study of dead data members in C++ applications, ACM SIGPLAN Notices, v.33 n.5, p.324-332, May 1998
- ◆ Karel Driesen , Urs Hözle, Accurate indirect branch prediction, ACM SIGARCH Computer Architecture News, v.26 n.3, p.167-178, June 1998
- ◆ Jong-Deok Choi , David Grove , Michael Hind , Vivek Sarkar, Efficient and precise modeling of exceptions for the analysis of Java programs, ACM SIGSOFT Software Engineering Notes, v.24 n.5, p.21-31, Sept. 1999
- ◆ Bjorn De Sutter , Bruno De Bus , Koen De Bosschere, Sifting out the mud: low level C++ code reuse, ACM SIGPLAN Notices, v.37 n.11, November 2002
- Jonathan Aldrich , Emin Gün Sirer , Craig Chambers , Susan J. Eggers, Comprehensive synchronization elimination for Java, Science of Computer Programming, v.47 n.2-3, p.91-120, May 2003
- ◆ Matthai Philipose , Craig Chambers , Susan J. Eggers, Towards automatic construction of staged compilers, ACM SIGPLAN Notices, v.37 n.1, p.113-125, Jan. 2002
- ◆ Craig Chambers, Towards reusable, extensible components, ACM Computing Surveys (CSUR), v.28 n.4es, Dec. 1996
- ◆ V. Karamcheti , C. Li , I. Pechtchanski , C. Yap, A core library for robust numeric and geometric computation, Proceedings of the fifteenth annual symposium on Computational geometry, p.351-359, June 13-16, 1999, Miami Beach, Florida, United States
- ◆ Norman Ramsey , Simon Peyton Jones, A single intermediate language that supports multiple

implementations of exceptions, ACM SIGPLAN Notices, v.35 n.5, p.285-298, May 2000

 Amer Diwan , Kathryn S. McKinley , J. Eliot B. Moss, Type-based alias analysis, ACM SIGPLAN Notices, v.33 n.5, p.106-117, May 1998

 Christopher League , Zhong Shao , Valery Trifonov, Representing Java classes in a typed intermediate language, ACM SIGPLAN Notices, v.34 n.9, p.183-196, Sept. 1999

 Craig Chambers, Staged compilation, ACM SIGPLAN Notices, v.37 n.3, March 2002

 Brendon Cahoon , Kathryn S. McKinley, Simple and effective array prefetching in Java, Proceedings of the 2002 joint ACM-ISCOPE conference on Java Grande, p.86-95, November 03-05, 2002, Seattle, Washington, USA

Raja Vallée-Rai , Phong Co , Etienne Gagnon , Laurie Hendren , Patrick Lam , Vijay Sundaresan, Soot - a Java bytecode optimization framework, Proceedings of the 1999 conference of the Centre for Advanced Studies on Collaborative research, p.13, November 08-11, 1999, Mississauga, Ontario, Canada

 Frederick Smith , Greg Morrisett, Comparing mostly-copying and mark-sweep conservative collection, ACM SIGPLAN Notices, v.34 n.3, p.68-78, March 1999

 Sorin Lerner , Todd Millstein , Erika Rice , Craig Chambers, Automated soundness proofs for dataflow analyses and transformations via local rules, ACM SIGPLAN Notices, v.40 n.1, p.364-377, January 2005

 Craig Chambers , Weimin Chen, Efficient multiple and predicated dispatching, ACM SIGPLAN Notices, v.34 n.10, p.238-255, Oct. 1999

 Greg DeFouw , David Grove , Craig Chambers, Fast interprocedural class analysis, Proceedings of the 25th ACM SIGPLAN-SIGACT symposium on Principles of programming languages, p.222-236, January 19-21, 1998, San Diego, California, United States

 Yanhong A. Liu , Scott D. Stoller , Michael Gorbovitski , Tom Rothamel , Yanni Ellen Liu, Incrementalization across object abstraction, ACM SIGPLAN Notices, v.40 n.10, October 2005

 Sorin Lerner , David Grove , Craig Chambers, Composing dataflow analyses and transformations, ACM SIGPLAN Notices, v.37 n.1, p.270-282, Jan. 2002

 Olivier Zendra , Dominique Colnet , Suzanne Collin, Efficient dynamic dispatch without virtual function tables: the SmallEiffel compiler, ACM SIGPLAN Notices, v.32 n.10, p.125-141, Oct. 1997

 Vijay Sundaresan , Laurie Hendren , Chrislain Razafimahafa , Raja Vallée-Rai , Patrick Lam , Etienne Gagnon , Charles Godin, Practical virtual method call resolution for Java, ACM SIGPLAN Notices, v.35 n.10, p.264-280, Oct. 2000

Dominic Duggan , John Ophel, Open and closed scopes for constrained genericity, Theoretical Computer Science, v.275 n.1-2, p.215-258, March 28 2002

 David Grove , Greg DeFouw , Jeffrey Dean , Craig Chambers, Call graph construction in object-oriented languages, ACM SIGPLAN Notices, v.32 n.10, p.108-124, Oct. 1997

Matthew Arnold , Michael Hsiao , Ulrich Kremer , Barbara G. Ryder, Exploring the Interaction between Java's Implicitly Thrown Exceptions and Instruction Scheduling, International Journal of Parallel Programming, v.29 n.2, p.111-137, April 2001

 Iffat H. Kazi , Howard H. Chen , Berdenia Stanley , David J. Lilja, Techniques for obtaining high performance in Java programs, ACM Computing Surveys (CSUR), v.32 n.3, p.213-240, Sept.

2000

- ◆ David Grove , Craig Chambers, A framework for call graph construction algorithms, ACM Transactions on Programming Languages and Systems (TOPLAS), v.23 n.6, p.685-746, November 2001
- ◆ Vassily Litvinov, Constraint-based polymorphism in Cecil: towards a practical and static type system, ACM SIGPLAN Notices, v.33 n.10, p.388-411, Oct. 1998
- ◆ Todd Millstein , Mark Reay , Craig Chambers, Relaxed MultiJava: balancing extensibility and modular typechecking, ACM SIGPLAN Notices, v.38 n.11, November 2003
- Jongwook Woo , Jean-Luc Gaudiot , Andrew L. Wendelborn, Alias analysis in Java with reference-set representation for high-performance computing, International Journal of Parallel Programming, v.32 n.1, p.39-76, February 2004
- ◆ Takeshi Ogasawara , Hideaki Komatsu , Toshio Nakatani, A study of exception handling and its dynamic optimization in Java, ACM SIGPLAN Notices, v.36 n.11, p.83-95, 11/01/2001
- ◆ Amer Diwan , Kathryn S. McKinley , J. Eliot B. Moss, Using types to analyze and optimize object-oriented programs, ACM Transactions on Programming Languages and Systems (TOPLAS), v.23 n.1, p.30-72, Jan. 2001
- ◆ Takeshi Ogasawara , Hideaki Komatsu , Toshio Nakatani, EDO: Exception-directed optimization in java, ACM Transactions on Programming Languages and Systems (TOPLAS), v.28 n.1, p.70-105, January 2006
- Remi Forax , Etienne Duris , Gilles Roussel, A Reflective Implementation of Java Multi-Methods, IEEE Transactions on Software Engineering, v.30 n.12, p.1055-1071, December 2004

#### ↑ INDEX TERMS

##### **Primary Classification:**

- D. Software
  - ↪ D.3 PROGRAMMING LANGUAGES
    - ↪ D.3.2 Language Classifications
      - ↪ **Subjects:** Object-oriented languages

##### **Additional Classification:**

- D. Software
  - ↪ D.1 PROGRAMMING TECHNIQUES
  - ↪ D.3 PROGRAMMING LANGUAGES
    - ↪ D.3.2 Language Classifications
      - ↪ **Nouns:** C++
  - ↪ D.3.4 Processors
    - ↪ **Subjects:** Optimization; Compilers

##### **General Terms:**

Design, Languages, Measurement, Performance

#### ↑ Collaborative Colleagues:

Craig Chambers:	Jonathan Aldrich Jonathan Erik Aldrich Darren C. Atkinson Joel Auslander Brian N. Bershad Colin Bleckner Bay-Wei Chang Weimin Chen Curtis Clifton Manuvir Das Greg DeFouw Jeffrey Dean Jeffrey Adgate Dean Susan Eggers Susan J. Eggers	Michael Ernst Bjorn Freeman-Benson Charles Garrett Brian Grant David Grove David Paul Grove Urs Hözlle Urs Hözlle Bill Harrison Antony Hosking Craig Kaplan Valentin Kostadinov Anthony LaMarca Gary T. Leavens Elgin Lee	Keunwoo Lee Sorin Lerner Sorin Lucian Lerner Vasily Litvinov Vassily Litvinov Chris Maeda Dylan McNamee Todd Millstein Todd D. Millstein Todd David Millstein Markus Mock Markus Ulrich Mock David Notkin Przemysław Pardyak Przemysław Pardyak	Igor Pechtchanski Matthai Philipose William Pugh Mark Reay Erika Rice Vivek Sarkar Stefan Savage Vibha Sazawal Mauricio J. Serrano Emin Gün Sirer Emin Gün Sirer Randall B. Smith Harini Srinivasan David Ungar John Vlissides
Greg DeFouw:	Craig Chambers Jeffrey Dean David Grove Vassily Litvinov Vaughan Pratt			
Jeffrey Dean:	Jennifer M. Anderson Lance M. Berc Krishna Bharat Andrei Broder Craig Chambers George Chrysos Greg DeFouw Charles Garrett Sanjay Ghemawat David Grove	Monika R. Henzinger James E. Hicks Shun-Tak A. Leung Vassily Litvinov Richard L. Sites Mark T. Vandevoorde Carl A. Waldspurger William E. Weihl		
David Grove:	Bowen Alpern Matthew Arnold David F. Bacon Hans-J. Boehm Michael G. Burke Maria Butrico Brad Calder Craig Chambers Perry Cheng Jong-Deok Choi	Anthony Cocchi John Corwin Greg DeFouw Jeffrey Dean Julian Dolby Stephen Fink Stephen J. Fink Charles Garrett Matthias Hauswirth Kim Hazelwood	Michael Hind Christoph M. Kirsch Chandra Krintz Sorin Lerner Derek Lieber Vassily Litvinov Jan-Willem Maessen Chet Murthy Ton Ngo V. T. Rajan	Vivek Sarkar Mauricio J. Serrano Daniel Spoonhower V. C. Sreedhar Harini Srinivasan Peter F. Sweeney Martin T. Vechev John Whaley Eran Yahav
Vassily Litvinov:	Craig Chambers Greg DeFouw Jeffrey Dean David Grove			

↑ Peer to Peer - Readers of this Article have also read:

- [Data structures for quadtree approximation and compression](#) **Communications of the ACM**

28, 9  
Hanan Samet

- A hierarchical single-key-lock access control using the Chinese remainder theorem **Proceedings of the 1992 ACM/SIGAPP Symposium on Applied computing**  
Kim S. Lee , Huizhu Lu , D. D. Fisher
- The GemStone object database management system **Communications of the ACM** 34, 10  
Paul Butterworth , Allen Otis , Jacob Stein
- An intelligent component database for behavioral synthesis **Proceedings of the 27th ACM/IEEE conference on Design automation**  
Gwo-Dong Chen , Daniel D. Gajski
- Putting innovation to work: adoption strategies for multimedia communication systems  
**Communications of the ACM** 34, 12  
Ellen Francik , Susan Ehrlich Rudman , Donna Cooper , Stephen Levine

↑ **This Article has also been published in:**

- **ACM SIGPLAN Notices**  
Volume 31, Issue 10 Oct. 1996

The ACM Portal is published by the Association for Computing Machinery. Copyright © 2007 ACM, Inc.  
[Terms of Usage](#) [Privacy Policy](#) [Code of Ethics](#) [Contact Us](#)

Useful downloads:  [Adobe Acrobat](#)  [QuickTime](#)  [Windows Media Player](#)  [Real Player](#)


[Web](#) [Images](#) [Video](#) [News](#) [Maps](#) [more »](#)





 Ad  
Sc  
Sc

**Scholar All articles - Recent articles** Results 1 - 10 of about 3,500 for **optimizing compiler static dynamic profile**
[All Results](#)
[C Chambers](#)
[J Dean](#)
[D Grove](#)
[R Jones](#)
[T Lindholm](#)

[Optimization of object-oriented programs using static class hierarchy analysis](#)

[- all 18 versions »](#)

J Dean, D Grove, C Chambers - Proceedings of the 9th European Conference on Object- ..., 1995 - cs.rpi.edu

... **Optimizing compilers for object-oriented languages apply ... class hierarchy analysis, the compiler can improve the quality of static class information and ...**

[Cited by 342 - Related Articles - View as HTML - Web Search - BL Direct](#)

[Vortex: an optimizing compiler for object-oriented languages - all 12 versions »](#)

J Dean, G DeFouw, D Grove, V Litvinov, C Chambers - Proceedings of the 11th ACM SIGPLAN conference on Object- ..., 1996 - portal.acm.org

... a language-independent **optimizing compiler** for object ... we describe the Vortex compiler's intermediate ... that intra- and interprocedural **static class analysis** ...

[Cited by 139 - Related Articles - Web Search - BL Direct](#)

[The Jalapeño dynamic optimizing compiler for Java - all 6 versions »](#)

MG Burke, JD Choi, S Fink, D Grove, M Hind, V ... - Proceedings of the ACM 1999 conference on Java Grande, 1999 - portal.acm.org

... would essentially function as a **static compiler** (as shown ... 2). When the Jalapeño Optimizing Compiler functions 88 a pure **dynamic compiler**, it must generate the ...

[Cited by 192 - Related Articles - Web Search](#)

[Optimizing compiler with static prediction of branch probability, branch frequency and function ... - all 3 versions »](#)

Y Wu - US Patent 5,655,122, 1997 - Google Patents

... 40 P rofiling information to **optimize** programs they write ... are used by the compiler to synthesize output ... An alternative is **static** profiling, in which a **compiler** ...

[Cited by 33 - Related Articles - Web Search](#)

[Partial method compilation using dynamic profile information - all 8 versions »](#)

»

J Whaley - ACM SIGPLAN Notices, 2001 - portal.acm.org

... performance that is comparable to **static** compilation techniques ... The idea of **optimizing** with respect to "hot ... The Multiflow **compiler** uses trace scheduling [33] to ...

[Cited by 48 - Related Articles - Web Search - BL Direct](#)

[Selective specialization for object-oriented languages - all 11 versions »](#)

J Dean, C Chambers, D Grove - Proceedings of the ACM SIGPLAN 1995 conference on ..., 1995 - portal.acm.org

... of set 2 to enable **static** binding to ... of the need for an **optimizing compiler** and some ... specializing exhaustively, our algorithm exploits **dynamic profile** data to ...

[Cited by 100 - Related Articles - Web Search - BL Direct](#)

[Garbage collection: algorithms for automatic dynamic memory management - all 5 versions »](#)

R Jones, R Lins - 1996 - John Wiley & Sons, Inc. New York, NY, USA

... stack collection and **profile**-driven pretotyping ... Gupta, Quicksilver: a quasi-**static compiler** for Java ... Whaley, The Jalapeño **dynamic optimizing compiler** for Java ...  
[Cited by 572](#) - [Related Articles](#) - [Web Search](#) - [Library Search](#)

**Using annotations to reduce **dynamic** optimization time - all 15 versions »**

C Krantz, B Calder - Proceedings of the ACM SIGPLAN 2001 conference on ..., 2001 - portal.acm.org

... Figure 1: ORP 03 (**Optimizing**) Compilation Time Breakdown ... meant to achieve this goal for the ORP **compiler**. ... We examine using annotations of both **static** and **profile** ...

[Cited by 49](#) - [Related Articles](#) - [Web Search](#)

**Profile-guided receiver class prediction - all 10 versions »**

D Grove, J Dean, C Garrett, C Chambers - ACM SIGPLAN Notices, 1995 - portal.acm.org

... to have significant potential for **optimizing** object-oriented ... code generated by our **C++ compiler** for a ... longer bc performed, either because **static** analysis was ...

[Cited by 96](#) - [Related Articles](#) - [Web Search](#) - [BL Direct](#)

**Reducing indirect function call overhead in C++ programs - all 12 versions »**

B Calder, D Grunwald - Proceedings of the 21st ACM SIGPLAN-SIGACT symposium on ..., 1994 - portal.acm.org

... accurate l-call prediction rates and, (4) we do a more in-depth comparison between different **static** and **dynamic** mechanisms for ... 2.1 Compiler Optimization ...

[Cited by 133](#) - [Related Articles](#) - [Web Search](#) - [BL Direct](#)

Google ►

Result Page: [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [Next](#)

[Google Home](#) - [About Google](#) - [About Google Scholar](#)

©2007 Google

[Web](#) [Images](#) [Video](#) [News](#) [Maps](#) [Gmail](#) [more ▾](#)
[Sign in](#)
[Google](#)

michael boucher + optimizing compiler static d

[Search](#)

[Advanced Search](#)

[Preferences](#)

[New! View and manage your web history](#)

Web Results 1 - 10 of about 402 for **michael boucher + optimizing compiler static dynamic runtime**. (0.38 se

### Compiler Technology/Implementation Techniques and Optimization

"Bigloo: a portable and **optimizing compiler** for strict functional languages". **Static Analysis** Symposium, SAS'95. September 1995. Available online: ps. ...  
[library.readscheme.org/page8.html](http://library.readscheme.org/page8.html) - 71k - [Cached](#) - [Similar pages](#)

### Compiler Construction

Run-Time Type Checking for Binary Programs. by: **Michael Burrows**, Stephen N. ...  
**Optimizing Static** Power Dissipation by Functional Units in Superscalar ...  
[wotan.liu.edu/docs/dbl/cccccc/index.html](http://wotan.liu.edu/docs/dbl/cccccc/index.html) - 89k - [Cached](#) - [Similar pages](#)

### Storage use analysis and its applications

17 David Andrew Kranz , Paul Hudak, Orbit: an **optimizing compiler** for scheme, ...  
 Matthias Neubauer , **Michael Sperber**, Down with Emacs Lisp: **dynamic** scope ...  
[portal.acm.org/citation.cfm?id=232635](http://portal.acm.org/citation.cfm?id=232635) - [Similar pages](#)

### [\[PDF\]](#) A Practical and Flexible Flow Analysis for Higher-Order Languages

File Format: PDF/Adobe Acrobat - [View as HTML](#)

**Static** and **dynamic** distribution of optimized procedure calls. .... during development and a highly-**optimizing** "batch mode" **compiler** when develop- ...  
[www.cs.indiana.edu/~dyb/papers/toplas97.pdf](http://www.cs.indiana.edu/~dyb/papers/toplas97.pdf) - [Similar pages](#)

### [\[PDF\]](#) Olin Shivers Educational background Employment History

File Format: PDF/Adobe Acrobat - [View as HTML](#)

Ported Orbit Scheme **compiler** to the IBM ROMP processor. .... Dissertation title: On **Static** and **Dynamic** Control-Flow Information in Program Analysis and ...  
[www.cc.gatech.edu/~shivers/cv.pdf](http://www.cc.gatech.edu/~shivers/cv.pdf) - [Similar pages](#)

### Bibliography generated from cbook.bib

Relating **static** and **dynamic** machine code measurements. Technical Report CS-89-03, ..... An **optimizing compiler** for the TMS320C25 DSP processor. ...  
[www.coding-guidelines.com/cbook/crefs.html](http://www.coding-guidelines.com/cbook/crefs.html) - 334k - [Cached](#) - [Similar pages](#)

### [\[PDF\]](#) Techniques for Optimizing Applications: High Performance Computing

File Format: PDF/Adobe Acrobat

the **dynamic runtime** behavior of applications, and in guiding the performance ..... for **static** executables. In the next section, we will discuss **compiler** ...  
[crc.nd.edu/information/documents/apt.pdf](http://crc.nd.edu/information/documents/apt.pdf) - [Similar pages](#)

### [\[PS\]](#) Partial Evaluation for Constraint-Based Program Analyses

File Format: Adobe PostScript - [View as Text](#)

is little benefit in applying **static** partial evaluation. One might rather perform. **dynamic** partial evaluation, i.e., incremental **runtime** code generation. ...  
[people.cis.ksu.edu/~tamtoft/Papers/Amt:PECPA-1999/long.ps](http://people.cis.ksu.edu/~tamtoft/Papers/Amt:PECPA-1999/long.ps) - [Similar pages](#)

### BibTeX

Z}, abstract = {Dynamic binding denotes a **runtime** lookup operation which extracts values ..... title = "TIL: A Type-Directed **Optimizing Compiler** for ML", ...  
[www.cs.kent.ac.uk/people/staff/cr3/bib/bibtex.html](http://www.cs.kent.ac.uk/people/staff/cr3/bib/bibtex.html) - 260k - [Cached](#) - [Similar pages](#)

### Scripting News 2004

The JRE is significantly larger than comparable **runtime** environments when considering ..... Memory footprint (**static** and **dynamic**); Speed (interpreter, ...  
[www.softpanorama.org/Scripting/Bulletin/scripting2004.shtml](http://www.softpanorama.org/Scripting/Bulletin/scripting2004.shtml) - 149k -  
[Cached](#) - [Similar pages](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [Next](#)

Try [Google Desktop](#): search your computer as easily as you search the web.

---

[Search within results](#) | [Language Tools](#) | [Search Tips](#) | [Dissatisfied? Help us improve](#)

---

©2007 Google - [Google Home](#) - [Advertising Programs](#) - [Business Solutions](#) - [About Google](#)


[Subscribe \(Full Service\)](#) [Register \(Limited Service, Free\)](#) [Login](#)

 Search:  The ACM Digital Library  The Guide

**THE GUIDE TO COMPUTING LITERATURE**

 Feedback [Report a problem](#) [Satisfaction survey](#)
**Dynamo: a transparent dynamic optimization system**
**Full text**  [Pdf \(156 KB\)](#)

**Source** [Conference on Programming Language Design and Implementation archive](#)  
[Proceedings of the ACM SIGPLAN 2000 conference on Programming language design and implementation table of contents](#)  
 Vancouver, British Columbia, Canada  
 Pages: 1 - 12  
 Year of Publication: 2000  
 ISSN:0362-1340  
[Also published in ...](#)

**Authors** [Vasanth Bala](#) Hewlett-Packard Labs 1 Main Street, Cambridge, MA  
[Evelyn Duesterwald](#) Hewlett-Packard Labs 1 Main Street, Cambridge, MA  
[Sanjeev Banerjia](#) Hewlett-Packard Labs 1 Main Street, Cambridge, MA

**Sponsors** [SIGPLAN: ACM Special Interest Group on Programming Languages](#)  
[SIGSOFT: ACM Special Interest Group on Software Engineering](#)

**Publisher** ACM Press New York, NY, USA

**Additional Information:** [abstract](#) [references](#) [cited by](#) [index terms](#) [collaborative colleagues](#) [peer to peer](#)

**Tools and Actions:** [Find similar Articles](#) [Review this Article](#)  
[Save this Article to a Binder](#) [Display Formats: BibTex](#) [EndNote](#) [ACM Ref](#)

**DOI Bookmark:** Use this link to bookmark this Article: <http://doi.acm.org/10.1145/349299.349303>  
[What is a DOI?](#)

**↑ ABSTRACT**

We describe the design and implementation of Dynamo, a software dynamic optimization system that is capable of transparently improving the performance of a native instruction stream as it executes on the processor. The input native instruction stream to Dynamo can be dynamically generated (by a JIT for example), or it can come from the execution of a statically compiled native binary. This paper evaluates the Dynamo system in the latter, more challenging situation, in order to emphasize the limits, rather than the potential, of the system. Our experiments demonstrate that even statically optimized native binaries can be accelerated by Dynamo, and often by a significant degree. For example, the average performance of -O optimized SpecInt95 benchmark binaries created by the HP product C compiler is improved to a level comparable to their -O4 optimized version running without Dynamo. Dynamo achieves this by focusing its efforts on optimization opportunities that tend to manifest only at runtime, and hence opportunities that might be difficult for a static compiler to exploit. Dynamo's operation is transparent in the sense that it does not depend on any user annotations or binary instrumentation, and does not require multiple runs, or any special compiler, operating system or hardware support. The Dynamo prototype presented here is a realistic implementation running on an HP PA-8000 workstation under the HPUX 10.20 operating system.

**↑ REFERENCES**

Note: OCR errors may be found in this Reference List extracted from the full text article. ACM has opted to expose the complete List rather than only correct and linked references.

- 1 [Joel Auslander, Matthai Philipose, Craig Chambers, Susan J. Eggers, Brian N. Bershad, Fast, effective dynamic compilation, Proceedings of the ACM SIGPLAN 1996 conference on Programming language design and implementation, p.149-159, May 21-24, 1996, Philadelphia, Pennsylvania, United States \[doi>10.1145/231379.231409\]](#)
- 2 [Bala, V., Duesterwald, E., and Banerjia, S. 1999. Transparent dynamic optimization: The design and implementation of Dynamo. Hewlett Packard Laboratories Technical Report HPL-1999-78. June 1999.](#)
- 3 [Bala V., and Freudenberger, S. 1996. Dynamic optimization: the Dynamo project at HP Labs Cambridge \(project proposal\). HP Labs internal memo, Feb 1996.](#)
- 4 [Thomas Ball, James R. Larus, Efficient path profiling, Proceedings of the 29th annual ACM/IEEE international symposium on Microarchitecture, p.46-57, December 02-04, 1996, Paris, France](#)
- 5 [Robert C. Bedichek, Talisman: fast and accurate multicomputer simulation, Proceedings of the 1995 ACM SIGMETRICS joint international conference on Measurement and modeling of computer systems, p.14-24, May 15-19, 1995, Ottawa, Ontario, Canada \[doi>10.1145/223586.223589\]](#)
- 6 [C. Chambers, D. Ungar, Customization: optimizing compiler technology for SELF, a dynamically-typed object-oriented programming language, Proceedings of the ACM SIGPLAN 1989 Conference on Programming language design and implementation, p.146-160, June 19-23, 1989, Portland, Oregon, United States \[doi>10.1145/73141.74831\]](#)
- 7 [Anton Chernoff, Mark Herdeg, Ray Hookway, Chris Reeve, Norman Rubin, Tony Tye, S. Bharadwaj Yadavalli, John Yates, FX!32: A Profile-Directed Binary Translator, IEEE Micro, v.18 n.2, p.56-64, March 1998 \[doi>10.1109/40.671403\]](#)
- 8 [Robert F. Cmelik, David Keppel, Shade: A Fast Instruction Set Simulator for Execution Profiling, Sun Microsystems, Inc., Mountain View, CA, 1993](#)
- 9 [Charles Consel, François Noël, A general approach for run-time specialization and its application to C, Proceedings of the 23rd ACM SIGPLAN-SIGACT symposium on Principles of programming languages, p.145-156, January 21-24, 1996, St. Petersburg Beach, Florida, United States \[doi>10.1145/237721.237767\]](#)
- 10 [Timothy Cramer, Richard Friedman, Terrence Miller, David Seberger, Robert Wilson, Mario Wolczko, Compiling Java Just in Time, IEEE Micro, v.17 n.3, p.36-43, May 1997 \[doi>10.1109/40.591653\]](#)
- 11 [L. Peter Deutsch, Allan M. Schiffman, Efficient implementation of the smalltalk-80 system, Proceedings of the 11th ACM SIGACT-SIGPLAN symposium on Principles of programming languages, p.297-302, January 15-18, 1984, Salt Lake City, Utah, United States \[doi>10.1145/800017.800542\]](#)
- 12 [Kemal Ebcioğlu, Erik R. Altman, DAISY: dynamic compilation for 100% architectural compatibility, Proceedings of the 24th annual international symposium on Computer architecture, p.26-37, June 01-04, 1997, Denver, Colorado, United States \[doi>10.1145/264107.264126\]](#)
- 13 [Dawson R. Engler, VCODE: a retargetable, extensible, very fast dynamic code generation system, Proceedings of the ACM SIGPLAN 1996 conference on Programming language design and implementation, p.160-170, May 21-24, 1996, Philadelphia, Pennsylvania, United States \[doi>10.1145/231379.231411\]](#)

14 Joseph A. Fisher , Stefan M. Freudenberger, Predicting conditional branch directions from previous runs of a program, Proceedings of the fifth international conference on Architectural support for programming languages and operating systems, p.85-95, October 12-15, 1992, Boston, Massachusetts, United States [doi>[10.1145/143365.143493](https://doi.org/10.1145/143365.143493)]

15 Daniel Holmes Friendly , Sanjay Jeram Patel , Yale N. Patt, Putting the fill unit to work: dynamic optimizations for trace cache microprocessors, Proceedings of the 31st annual ACM/IEEE international symposium on Microarchitecture, p.173-181, November 1998, Dallas, Texas, United States

16 Brian Grant , Matthai Philipose , Markus Mock , Craig Chambers , Susan J. Eggers, An evaluation of staged run-time optimizations in DyC, Proceedings of the ACM SIGPLAN 1999 conference on Programming language design and implementation, p.293-304, May 01-04, 1999, Atlanta, Georgia, United States [doi>[10.1145/301618.301683](https://doi.org/10.1145/301618.301683)]

17 Herold, S.A. 1998. Using complete machine simulation to understand computer system behavior. Ph.D. thesis, Dept. Computer Science, Stanford University.

18 Wen-Mei W. Hwu , Scott A. Mahlke , William Y. Chen , Pohua P. Chang , Nancy J. Warter , Roger A. Bringmann , Roland G. Ouellette , Richard E. Hank , Tokuzo Kiyohara , Grant E. Haab , John G. Holm , Daniel M. Lavery, The superblock: an effective technique for VLIW and superscalar compilation, The Journal of Supercomputing, v.7 n.1-2, p.229-248, May 1993 [doi>[10.1007/BF01205185](https://doi.org/10.1007/BF01205185)]

19 Keller, J. 1996. The 21264: a superscalar Alpha processor with out-of-order execution. Presented at the 9th Annual Microprocessor Forum, San Jose, CA.

20 Kelly, E.K., Cmelik, R.F., and Wing, M.J. 1998. Memory controller for a microprocessor for detecting a failure of speculation on the physical nature of a component being addressed. U.S. Patent 5,832,205, Nov. 1998.

21 Kumar, A. 1996. The HP PA-8000 RISC CPU: a high performance out-of-order processor. In Proceedings of Hot Chips VIII, Palo Alto, CA.

22 Leone, M. and Dybvig, R.K. 1997. Dynamo: a staged compiler architecture for dynamic program optimization. Technical Report #490, Dept. of Computer Science, Indiana University.

23 Peter Lee , Mark Leone, Optimizing ML with run-time code generation, Proceedings of the ACM SIGPLAN 1996 conference on Programming language design and implementation, p.137-148, May 21-24, 1996, Philadelphia, Pennsylvania, United States [doi>[10.1145/231379.231407](https://doi.org/10.1145/231379.231407)]

24 Renaud Marlet , Charles Consel , Philippe Boinot, Efficient incremental run-time specialization for free, Proceedings of the ACM SIGPLAN 1999 conference on Programming language design and implementation, p.281-292, May 01-04, 1999, Atlanta, Georgia, United States [doi>[10.1145/301618.301681](https://doi.org/10.1145/301618.301681)]

25 David B. Papworth, Tuning the Pentium Pro Microarchitecture, IEEE Micro, v.16 n.2, p.8-15, April 1996 [doi>[10.1109/40.491458](https://doi.org/10.1109/40.491458) ]

26 Massimiliano Poletto , Dawson R. Engler , M. Frans Kaashoek, tcc: a system for fast, flexible, and high-level dynamic code generation, Proceedings of the ACM SIGPLAN 1997 conference on Programming language design and implementation, p.109-121, June 16-18, 1997, Las Vegas, Nevada, United States [doi>[10.1145/258915.258926](https://doi.org/10.1145/258915.258926)]

27 Eric Rotenberg , Steve Bennett , James E. Smith, Trace cache: a low latency approach to high bandwidth instruction fetching, Proceedings of the 29th annual ACM/IEEE international symposium on Microarchitecture, p.24-35, December 02-04, 1996, Paris,

France

28 Michael Sannella , John Maloney , Bjorn Freeman-Benson , Alan Borning, Multi-way versus one-way constraints in user interfaces: experience with the DeltaBlue algorithm, Software—Practice & Experience, v.23 n.5, p.529-566, May 1993  
[doi>[10.1002/spe.4380230507](https://doi.org/10.1002/spe.4380230507)]

29 Sites, R.L., Chernoff, A., Kirk, M.B., Marks, M.P., and Robinson, S.G. Binary Translation. Digital Technical Journal, Vol 4, No. 4, Special Issue, 1992.

30 Stears, P. 1994. Emulating the x86 and DOS/Windows in RISC environments. In Proceedings of the Microprocessor Forum, San Jose, CA.

31 Emmett Witchel , Mendel Rosenblum, Embar: fast and flexible machine simulation, Proceedings of the 1996 ACM SIGMETRICS international conference on Measurement and modeling of computer systems, p.68-79, May 23-26, 1996, Philadelphia, Pennsylvania, United States [doi>[10.1145/233008.233025](https://doi.org/10.1145/233008.233025)]

**↑ CITED BY 105**

 Alex Ramirez , Oliverio J. Santana , Josep L. Larriba-Pey , Mateo Valero, Fetching instruction streams, Proceedings of the 35th annual ACM/IEEE international symposium on Microarchitecture, November 18-22, 2002, Istanbul, Turkey

 Andrew A. Lamb , William Thies , Saman Amarasinghe, Linear analysis and optimization of stream programs, ACM SIGPLAN Notices, v.38 n.5, May 2003

 Amir Roth , Gurindar S. Sohi, A quantitative framework for automated pre-execution thread selection, Proceedings of the 35th annual ACM/IEEE international symposium on Microarchitecture, November 18-22, 2002, Istanbul, Turkey

 Jaydeep Marathe , Frank Mueller , Tushar Mohan , Bronis R. de Supinski , Sally A. McKee , Andy Yoo, METRIC: tracking down inefficiencies in the memory hierarchy via binary rewriting, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

 K. Scott , N. Kumar , S. Velusamy , B. Childers , J. W. Davidson , M. L. Soffa, Retargetable and reconfigurable software dynamic translation, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

 Scott McFarling, Reality-based optimization, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

 Greg Stitt , Roman Lysecky , Frank Vahid, Dynamic hardware/software partitioning: a first approach, Proceedings of the 40th conference on Design automation, June 02-06, 2003, Anaheim, CA, USA

 Sathyanarayanan Thammanur , Santosh Pande, A fast, memory-efficient register allocation framework for embedded systems, ACM Transactions on Programming Languages and Systems (TOPLAS), v.26 n.6, p.938-974, November 2004

 Lian Li , Jingling Xue, A trace-based binary compilation framework for energy-aware computing, ACM SIGPLAN Notices, v.39 n.7, July 2004

 Giuseppe Desoli , Nikolay Mateev , Evelyn Duesterwald , Paolo Faraboschi , Joseph A. Fisher, DELI: a new run-time control point, Proceedings of the 35th annual ACM/IEEE international symposium on Microarchitecture, November 18-22, 2002, Istanbul, Turkey

Ahmad Zmily , Christos Kozyrakis, Simultaneously improving code size, performance, and energy in embedded processors, Proceedings of the conference on Design, automation and test in Europe: Proceedings, March 06-10, 2006, Munich, Germany

 Efe Yardimci , Michael Franz, Dynamic parallelization and mapping of binary executables on hierarchical platforms, Proceedings of the 3rd conference on Computing frontiers, May 03-05, 2006, Ischia, Italy

 Laune C. Harris , Barton P. Miller, Practical analysis of stripped binary code, ACM SIGARCH Computer Architecture News, v.33 n.5, December 2005

 Lin Gu , John A. Stankovic, t-kernel: providing reliable OS support to wireless sensor networks, Proceedings of the 4th international conference on Embedded networked sensor systems, October 31-November 03, 2006, Boulder, Colorado, USA

 Markus Mock , Craig Chambers , Susan J. Eggers, Calpa: a tool for automating selective dynamic compilation, Proceedings of the 33rd annual ACM/IEEE international symposium on Microarchitecture, p.291-302, December 2000, Monterey, California, United States

 Mohan Rajagopalan , Saumya K. Debray , Matti A. Hiltunen , Richard D. Schlichting, Profile-directed optimization of event-based programs, ACM SIGPLAN Notices, v.37 n.5, May 2002

Marc Tremblay , Jeffrey Chan , Shailender Chaudhry , Andrew W. Conigliaro , Shing Sheung Tse, The MAJC Architecture: A Synthesis of Parallelism and Scalability, IEEE Micro, v.20 n.6, p.12-25, November 2000

 Marc L. Corliss , E. Christopher Lewis , Amir Roth, DISE: a programmable macro engine for customizing applications, ACM SIGARCH Computer Architecture News, v.31 n.2, May 2003

 Karl Pettis , Robert C. Hansen , Jack W. Davidson, Profile guided code positioning, ACM SIGPLAN Notices, v.39 n.4, April 2004

 Glenn Ammons , James R. Larus, Improving data-flow analysis with path profiles, ACM SIGPLAN Notices, v.39 n.4, April 2004

 Karthik Sankaranarayanan , Kevin Skadron, Profile-based adaptation for cache decay, ACM Transactions on Architecture and Code Optimization (TACO), v.1 n.3, p.305-322, September 2004

 Yolanta Beres , Chris I. Dalton, Dynamic label binding at run-time, Proceedings of the 2003 workshop on New security paradigms, August 18-21, 2003, Ascona, Switzerland

Kwok Yeung , Paul H. J. Kelly , Sarah Bennett, Dynamic instrumentation for Java using a virtual JVM, Performance analysis and grid computing, Kluwer Academic Publishers, Norwell, MA, 2004

 Naveen Kumar , Bruce R. Childers , Mary Lou Soffa, Tdb: a source-level debugger for dynamically translated programs, Proceedings of the sixth international symposium on Automated analysis-driven debugging, p.123-132, September 19-21, 2005, Monterey, California, USA

 Benjamin Vitale , Tarek S. Abdelrahman, Catenation and specialization for Tcl virtual machine performance, Proceedings of the 2004 workshop on Interpreters, virtual machines and emulators, June 07-07, 2004, Washington, D.C.

 Toshio Suganuma , Toshiaki Yasue , Toshio Nakatani, A region-based compilation technique for dynamic compilers, ACM Transactions on Programming Languages and Systems (TOPLAS), v.28 n.1, p.134-174, January 2006

 Naveen Kumar , Jonathan Misurda , Bruce R. Childers , Mary Lou Soffa, Instrumentation in software dynamic translators for self-managed systems, Proceedings of the 1st ACM SIGSOFT

workshop on Self-managed systems, p.90-94, October 31-November 01, 2004, Newport Beach, California

Lingli Zhang , Chandra Krintz, Profile-driven code unloading for resource-constrained JVMs, Proceedings of the 3rd international symposium on Principles and practice of programming in Java, June 16-18, 2004, Las Vegas, Nevada

 Naveen Kumar , Bruce R. Childers , Mary Lou Soffa, Low overhead program monitoring and profiling, ACM SIGSOFT Software Engineering Notes, v.31 n.1, January 2006

James E. Smith , Ravi Nair, The Architecture of Virtual Machines, Computer, v.38 n.5, p.32-38, May 2005

David Ung , Cristina Cifuentes, Dynamic binary translation using run-time feedbacks, Science of Computer Programming, v.60 n.2, p.189-204, April 2006

 Jason E. Miller , Anant Agarwal, Software-based instruction caching for embedded processors, ACM SIGOPS Operating Systems Review, v.40 n.5, December 2006

 Jing Yang , Shukang Zhou , Mary Lou Soffa, Dimension: an instrumentation tool for virtual execution environments, Proceedings of the second international conference on Virtual execution environments, June 14-16, 2006, Ottawa, Ontario, Canada

 Vijay Janapa Reddi , Dan Connors , Robert S. Cohn, Persistence in dynamic code transformation systems, ACM SIGARCH Computer Architecture News, v.33 n.5, December 2005

 Sanjay Bhansali , Wen-Ke Chen , Stuart de Jong , Andrew Edwards , Ron Murray , Milenko Drinić , Darek Mihočka , Joe Chau, Framework for instruction-level tracing and analysis of program executions, Proceedings of the second international conference on Virtual execution environments, June 14-16, 2006, Ottawa, Ontario, Canada

 Youtao Zhang , Rajiv Gupta, Timestamped whole program path representation and its applications, ACM SIGPLAN Notices, v.36 n.5, p.180-190, May 2001

 Toshio Suganuma , Toshiaki Yasue , Toshio Nakatani, A region-based compilation technique for a Java just-in-time compiler, ACM SIGPLAN Notices, v.38 n.5, May 2003

Howard Chen , Wei-Chung Hsu , Jiwei Lu , Pen-Chung Yew , Dong-Yuan Chen, Dynamic trace selection using performance monitoring hardware sampling, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

 Ann Gordon-Ross , Frank Vahid, Frequent loop detection using efficient non-intrusive on-chip hardware, Proceedings of the 2003 international conference on Compilers, architecture and synthesis for embedded systems, October 30-November 01, 2003, San Jose, California, USA

 Kim Hazelwood , Artur Klauser, A dynamic binary instrumentation engine for the ARM architecture, Proceedings of the 2006 international conference on Compilers, architecture and synthesis for embedded systems, October 22-25, 2006, Seoul, Korea

Ronald D. Barnes , Erik M. Nyström , Matthew C. Merten , Wen-mei W. Hwu, Vacuum packing: extracting hardware-detected program phases for post-link optimization, Proceedings of the 35th annual ACM/IEEE international symposium on Microarchitecture, November 18-22, 2002, Istanbul, Turkey

Kim Hazelwood , David Brooks, Eliminating voltage emergencies via microarchitectural voltage

- ◆ [control feedback and dynamic optimization, Proceedings of the 2004 international symposium on Low power electronics and design, August 09-11, 2004, Newport Beach, California, USA](#)
- ◆ [Roman Lysecky , Susan Cotterell , Frank Vahid, A fast on-chip profiler memory, Proceedings of the 39th conference on Design automation, June 10-14, 2002, New Orleans, Louisiana, USA](#)
- ◆ [Andrew Ayers , Richard Schooler , Chris Metcalf , Anant Agarwal , Junghwan Rhee , Emmett Witchel, TraceBack: first fault diagnosis by reconstruction of distributed control flow, ACM SIGPLAN Notices, v.40 n.6, June 2005](#)
- [Marc Berndl , Laurie Hendren, Dynamic profiling and trace cache generation, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California](#)
- [Mathew Zaleski , Marc Berndl , Angela Demke Brown, Mixed mode execution with context threading, Proceedings of the 2005 conference of the Centre for Advanced Studies on Collaborative research, p.305-319, October 17-20, 2005, Toronto, Ontario, Canada](#)
- ◆ [Sebastian Unger , Frank Mueller, Handling irreducible loops: optimized node splitting versus DJ-graphs, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.24 n.4, p.299-333, July 2002](#)
- ◆ [Suhas Gupta , Pranay Pratap , Huzur Saran , S. Arun-Kumar, Dynamic code instrumentation to detect and recover from return address corruption, Proceedings of the 2006 international workshop on Dynamic systems analysis, May 23-23, 2006, Shanghai, China](#)
- ◆ [Swaroop Sridhar , Jonathan S. Shapiro , Eric Northup , Prashanth P. Bungale, HDTrans: an open source, low-level dynamic instrumentation system, Proceedings of the second international conference on Virtual execution environments, June 14-16, 2006, Ottawa, Ontario, Canada](#)

- ◆ [Oliverio J. Santana , Ayose Falcón , Alex Ramirez , Mateo Valero, Branch predictor guided instruction decoding, Proceedings of the 15th international conference on Parallel architectures and compilation techniques, September 16-20, 2006, Seattle, Washington, USA](#)
- ◆ [Ahmad Zmily , Christos Kozyrakis, Block-aware instruction set architecture, ACM Transactions on Architecture and Code Optimization \(TACO\), v.3 n.3, p.327-357, September 2006](#)
- ◆ [S. Subramanya Sastry , Rastislav Bodík , James E. Smith, Rapid profiling via stratified sampling, ACM SIGARCH Computer Architecture News, v.29 n.2, p.278-289, May 2001](#)
- ◆ [Trishul M. Chilimbi , Martin Hirzel, Dynamic hot data stream prefetching for general-purpose programs, ACM SIGPLAN Notices, v.37 n.5, May 2002](#)
- ◆ [Evelyn Duesterwald , Vasanth Bala, Software profiling for hot path prediction: less is more, ACM SIGPLAN Notices, v.35 n.11, p.202-211, Nov. 2000](#)
- ◆ [Evelyn Duesterwald , Vasanth Bala, Software profiling for hot path prediction: less is more, ACM SIGOPS Operating Systems Review, v.34 n.5, p.202-211, Dec. 2000](#)
- [Derek Bruening , Timothy Garnett , Saman Amarasinghe, An infrastructure for adaptive dynamic optimization, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California](#)
- [Ho-Seop Kim , James E. Smith, Dynamic binary translation for accumulator-oriented architectures, Proceedings of the international symposium on Code generation and](#)

optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

James C. Dehnert, Brian K. Grant, John P. Banning, Richard Johnson, Thomas Kistler, Alexander Klaiber, Jim Mattson, The Transmeta Code Morphing™ Software: using speculation, recovery, and adaptive retranslation to address real-life challenges, Proceedings of the international symposium on Code generation and optimization: feedback-directed and runtime optimization, March 23-26, 2003, San Francisco, California

 Saumya Debray, William Evans, Profile-guided code compression, ACM SIGPLAN Notices, v.37 n.5, May 2002

 Mike Jochen, Anteneh Addis Anteneh, Lori L. Pollock, Lisa M. Marvel, Enabling control over adaptive program transformation for dynamically evolving mobile software validation, ACM SIGSOFT Software Engineering Notes, v.30 n.4, July 2005

 Roman Lysecky, Frank Vahid, Sheldon X.-D. Tan, Dynamic FPGA routing for just-in-time FPGA compilation, Proceedings of the 41st annual conference on Design automation, June 07-11, 2004, San Diego, CA, USA

 Gregory T. Sullivan, Derek L. Bruening, Iris Baron, Timothy Garnett, Saman Amarasinghe, Dynamic native optimization of interpreters, Proceedings of the 2003 workshop on Interpreters, virtual machines and emulators, p.50-57, June 12-12, 2003, San Diego, California

 Keith Adams, Ole Agesen, A comparison of software and hardware techniques for x86 virtualization, ACM SIGOPS Operating Systems Review, v.40 n.5, December 2006

 Matthai Philipose, Craig Chambers, Susan J. Eggers, Towards automatic construction of staged compilers, ACM SIGPLAN Notices, v.37 n.1, p.113-125, Jan. 2002

 John Whaley, Partial method compilation using dynamic profile information, ACM SIGPLAN Notices, v.36 n.11, p.166-179, 11/01/2001

 Greg Stitt, Frank Vahid, Hardware/software partitioning of software binaries, Proceedings of the 2002 IEEE/ACM international conference on Computer-aided design, p.164-170, November 10-14, 2002, San Jose, California

 Andy Georges, Dries Buytaert, Lieven Eeckhout, Koen De Bosschere, Method-level phase behavior in java workloads, ACM SIGPLAN Notices, v.39 n.10, October 2004

 Sitij Agrawal, William Thies, Saman Amarasinghe, Optimizing stream programs using linear state space analysis, Proceedings of the 2005 international conference on Compilers, architectures and synthesis for embedded systems, September 24-27, 2005, San Francisco, California, USA

 Shukang Zhou, Bruce R. Childers, Mary Lou Soffa, Planning for code buffer management in distributed virtual execution environments, Proceedings of the 1st ACM/USENIX international conference on Virtual execution environments, June 11-12, 2005, Chicago, IL, USA

 Lingli Zhang, Chandra Krintz, The design, implementation, and evaluation of adaptive code unloading for resource-constrained devices, ACM Transactions on Architecture and Code Optimization (TACO), v.2 n.2, p.131-164, June 2005

 Toshihiko Koju, Shingo Takada, Norihisa Doi, An efficient and generic reversible debugger using the virtual machine based approach, Proceedings of the 1st ACM/USENIX international conference on Virtual execution environments, June 11-12, 2005, Chicago, IL, USA

Priya Nagpurkar, Chandra Krintz, Phase-based visualization and analysis of Java programs, Science of Computer Programming, v.59 n.1-2, p.64-81, January 2006

Naveen Kumar , Bruce R. Childers , Daniel Williams , Jack W. Davidson , Mary Lou Soffa, Compile-time planning for overhead reduction in software dynamic translators, International Journal of Parallel Programming, v.33 n.2, p.103-114, June 2005

 Shiwen Hu , Madhavi Valluri , Lizy Kurian John, Effective management of multiple configurable units using dynamic optimization, ACM Transactions on Architecture and Code Optimization (TACO), v.3 n.4, p.477-501, December 2006

 Rodric M. Rabbah , Hariharan Sandanagobalane , Mongkol Ekpanyapong , Weng-Fai Wong, Compiler orchestrated prefetching via speculation and predication, ACM SIGPLAN Notices, v.39 n.11, November 2004

 Bjorn De Sutter , Bruno De Bus , Koen De Bosschere, Link-time binary rewriting techniques for program compaction, ACM Transactions on Programming Languages and Systems (TOPLAS), v.27 n.5, p.882-945, September 2005

 Elena Gabriela Barrantes , David H. Ackley , Stephanie Forrest , Darko Stefanović, Randomized instruction set emulation, ACM Transactions on Information and System Security (TISSEC), v.8 n.1, p.3-40, February 2005

Ann Gordon-Ross , Frank Vahid, Frequent Loop Detection Using Efficient Nonintrusive On-Chip Hardware, IEEE Transactions on Computers, v.54 n.10, p.1203-1215, October 2005

 Kim Hazelwood , Michael D. Smith, Managing bounded code caches in dynamic binary optimization systems, ACM Transactions on Architecture and Code Optimization (TACO), v.3 n.3, p.263-294, September 2006

 Toshio Suganuma , Toshiaki Yasue , Motohiro Kawahito , Hideaki Komatsu , Toshio Nakatani, A dynamic optimization framework for a Java just-in-time compiler, ACM SIGPLAN Notices, v.36 n.11, p.180-195, 11/01/2001

 Matthew Arnold , Barbara G. Ryder, A framework for reducing the cost of instrumented code, ACM SIGPLAN Notices, v.36 n.5, p.168-179, May 2001

 S. M. Sandya, Jazzing up JVMs with off-line profile data: does it pay?, ACM SIGPLAN Notices, v.39 n.8, August 2004

 Matthew Arnold , Stephen Fink , David Grove , Michael Hind , Peter F. Sweeney, Adaptive optimization in the Jalapeño JVM, ACM SIGPLAN Notices, v.35 n.10, p.47-65, Oct. 2000

 Ajeet Shankar , S. Subramanya Sastry , Rastislav Bodík , James E. Smith, Runtime specialization with optimistic heap analysis, ACM SIGPLAN Notices, v.40 n.10, October 2005

 Michael D. Smith, Overcoming the challenges to feedback-directed optimization (Keynote Talk), ACM SIGPLAN Notices, v.35 n.7, p.1-11, July 2000

 Dinesh C. Suresh , Walid A. Najjar , Frank Vahid , Jason R. Villarreal , Greg Stitt, Profiling tools for hardware/software partitioning of embedded applications, ACM SIGPLAN Notices, v.38 n.7, July 2003

 Antonio Carlos S. Beck , Victor F. Gomes , Luigi Carro, Exploiting Java through binary translation for low power embedded reconfigurable systems, Proceedings of the 18th annual symposium on Integrated circuits and system design, September 04-07, 2005, Florianopolis, Brazil

 Michael J. Voss , Rudolf Eigemann, High-level adaptive program optimization with ADAPT, ACM SIGPLAN Notices, v.36 n.7, p.93-102, July 2001

Elena Gabriela Barrantes , David H. Ackley , Trek S. Palmer , Darko Stefanovic , Dino Dai Zovi,

- ◆ Randomized instruction set emulation to disrupt binary code injection attacks, Proceedings of the 10th ACM conference on Computer and communications security, October 27-30, 2003, Washington D.C., USA
- ◆ Matthew Arnold , Michael Hind , Barbara G. Ryder, Online feedback-directed optimization of Java, ACM SIGPLAN Notices, v.37 n.11, November 2002
- ◆ Toshio Suganuma , Toshiaki Yasue , Motohiro Kawahito , Hideaki Komatsu , Toshio Nakatani, Design and evaluation of dynamic optimizations for a Java just-in-time compiler, ACM Transactions on Programming Languages and Systems (TOPLAS), v.27 n.4, p.732-785, July 2005
- ◆ K. V. Seshu Kumar, When and what to compile/optimize in a virtual machine?, ACM SIGPLAN Notices, v.39 n.3, March 2004
- ◆ Gaurav Mittal , David Zaretsky , Gokhan Memik , Prith Banerjee, Automatic extraction of function bodies from software binaries, Proceedings of the 2005 conference on Asia South Pacific design automation, January 18-21, 2005, Shanghai, China
- Lian Li , Jingling Xue, Trace-based leakage energy optimisations at link time, Journal of Systems Architecture: the EUROMICRO Journal, v.53 n.1, p.1-20, January, 2007
- William C. Kreahling , David Whalley , Mark W. Bailey , Xin Yuan , Gang-Ryung Uh , Robert van Engelen, Branch elimination by condition merging, Software—Practice & Experience, v.35 n.1, p.51-74, January 2005
- ◆ Gaurav Mittal , David C. Zaretsky , Xiaoyong Tang , P. Banerjee, Automatic translation of software binaries onto FPGAs, Proceedings of the 41st annual conference on Design automation, June 07-11, 2004, San Diego, CA, USA
- ◆ Jianhui Li , Peng Zhang , Orna Etzion, Module-aware translation for real-life desktop applications, Proceedings of the 1st ACM/USENIX international conference on Virtual execution environments, June 11-12, 2005, Chicago, IL, USA
- ◆ Ashutosh S. Dhadapkar , James E. Smith, Managing multi-configuration hardware via dynamic working set analysis, ACM SIGARCH Computer Architecture News, v.30 n.2, May 2002
- ◆ Madhavi G. Valluri , Lizy K. John , Kathryn S. McKinley, Low-power, low-complexity instruction issue using compiler assistance, Proceedings of the 19th annual international conference on Supercomputing, June 20-22, 2005, Cambridge, Massachusetts
- ◆ Bjorn De Sutter , Bruno De Bus , Koen De Bosschere, Sifting out the mud: low level C++ code reuse, ACM SIGPLAN Notices, v.37 n.11, November 2002

## ↑ INDEX TERMS

### Primary Classification:

**D. Software**

- ↪ **D.3 PROGRAMMING LANGUAGES**
- ↪ **D.3.4 Processors**
- ↪ **Subjects: Optimization**

### Additional Classification:

**D. Software**

- ↪ **D.4 OPERATING SYSTEMS**

**General Terms:**Algorithms, Design, Performance**↑ Collaborative Colleagues:**

Vasanth Bala:

Bowen Alpern  
 Joshua Auerbach  
 Sanjeev Banerjia  
 Jehoshua Bruck  
 Raymond Bryant  
 Larry Carter  
 Robert Cypher  
 Ron Cytron  
 Evelyn Duesterwald  
 Pablo Elustando

Pablo Elustando  
 Jeanne Ferrante  
 Thomas Frauenhofer  
 D. Frye  
 Alex Ho  
 Ching-Tien Ho  
 Wei Hsu  
 Gail Irwin  
 Shlomo Kipnis  
 Richard Lawrence

Todd Mummert  
 Michael Pigott  
 Norman Rubin  
 Marc Snir  
 Peter de Jong

Sanjeev Banerjia:

Emre Özer  
 Vasanth Bala  
 Grif Bilbro  
 Thomas M. Conte  
 Evelyn Duesterwald  
 Paul Franzon  
 Alan Glaser  
 Christoforos Harvatis  
 William A. Havanki  
 Matthew D. Jennings

Sergei Y. Larin  
 Steve Lipa  
 Kishore N. Menezes  
 Emre Ozer  
 Real Pomerleau  
 Sumedh W. Sathaye  
 Toby Schaffer  
 Andrew Stanaski  
 Yusuf Tekmen

Evelyn Duesterwald:

Vasanth Bala  
 Sanjeev Banerjia  
 Calin Cascaval  
 Calin Cascaval  
 Giuseppe Desoli  
 Sandhya Dwarkadas  
 Paolo Faraboschi  
 Joseph A. Fisher  
 Josh Fisher  
 Rajiv Gupta

Nikolay Mateev  
 Mary Lou Soffa  
 Mary Lou Soffa  
 Peter F. Sweeney  
 Robert W. Wisniewski  
 Yuan Zhang

**↑ Peer to Peer - Readers of this Article have also read:**

- Data structures for quadtree approximation and compression **Communications of the ACM** 28, 9  
Hanan Samet
- A hierarchical single-key-lock access control using the Chinese remainder theorem **Proceedings of the 1992 ACM/SIGAPP Symposium on Applied computing**  
Kim S. Lee , Huiwu Lu , D. D. Fisher
- An intelligent component database for behavioral synthesis **Proceedings of the 27th ACM/IEEE conference on Design automation**  
Gwo-Dong Chen , Daniel D. Gajski
- The GemStone object database management system **Communications of the ACM** 34, 10  
Paul Butterworth , Allen Otis , Jacob Stein
- Putting innovation to work: adoption strategies for multimedia communication systems **Communications of the ACM** 34, 12  
Ellen Francik , Susan Ehrlich Rudman , Donna Cooper , Stephen Levine

↑ **This Article has also been published in:**

- **ACM SIGPLAN Notices**  
Volume 35, Issue 5 May 2000

The ACM Portal is published by the Association for Computing Machinery. Copyright © 2007 ACM, Inc.

[Terms of Usage](#) [Privacy Policy](#) [Code of Ethics](#) [Contact Us](#)

Useful downloads:  [Adobe Acrobat](#)  [QuickTime](#)  [Windows Media Player](#)  [Real Player](#)


[Subscribe \(Full Service\)](#) [Register \(Limited Service, Free\)](#) [Login](#)

 Search:  The ACM Digital Library  The Guide

## THE GUIDE TO COMPUTING LITERATURE

[Feedback](#) [Report a problem](#) [Satisfaction survey](#)

### Type feedback vs. concrete type inference: a comparison of optimization techniques for object-oriented languages

Full text  [Pdf \(2.27 MB\)](#)

Source [ACM SIGPLAN Notices archive](#)

Volume 30, Issue 10 (October 1995) [table of contents](#)

Pages: 91 - 107

Year of Publication: 1995

ISSN:0362-1340

[Also published in ...](#)

Authors [Ole Agesen](#) Computer Science Department, Stanford University, Stanford, CA

[Urs Hözle](#) Computer Science Department, University of California, Santa Barbara, CA

Publisher ACM Press New York, NY, USA

Additional Information: [abstract](#) [references](#) [cited by](#) [index terms](#) [collaborative colleagues](#) [peer to peer](#)

Tools and Actions: [Find similar Articles](#) [Review this Article](#)

[Save this Article to a Binder](#) [Display Formats: BibTeX](#) [EndNote](#) [ACM Ref](#)

DOI Bookmark: Use this link to bookmark this Article: <http://doi.acm.org/10.1145/217839.217847>

[What is a DOI?](#)

#### ↑ ABSTRACT

Two promising optimization techniques for object-oriented languages are type feedback (profile-based receiver class prediction) and concrete type inference (static analysis). We directly compare the two techniques, evaluating their effectiveness on a suite of 23 SELF programs while keeping other factors constant. Our results show that both systems inline over 95% of all sends and deliver similar overall performance with one exception: SELF's automatic coercion of machine integers to arbitrary-precision integers upon overflow confounds type inference and slows down arithmetic-intensive benchmarks. We discuss several other issues which, given the comparable run-time performance, may influence the choice between type feedback and type inference.

#### ↑ REFERENCES

Note: OCR errors may be found in this Reference List extracted from the full text article. ACM has opted to expose the complete List rather than only correct and linked references.

Age94 Ole Agesen. Constraint-Based Type Inference and Parametric Polymorphism. in SAS '94, First International Static Analysis Symposium, p. 78-100, Namur, Belgium, Sept. 1994. Springer-Verlag (LNCS 864).

AU94 [Ole Agesen, David Ungar, Sifting out the gold: delivering compact applications from an exploratory object-oriented programming environment, Proceedings of the ninth annual conference on Object-oriented programming systems, language, and](#)

[applications, p.355-370, October 23-28, 1994, Portland, Oregon, United States](#)  
 [doi>[10.1145/191080.191135](#)]

Age95 [Ole Agesen, The Cartesian Product Algorithm: Simple and Precise Type Inference Of Parametric Polymorphism, Proceedings of the 9th European Conference on Object-Oriented Programming, p.2-26, August 07-11, 1995](#)

AH95 [Ole Agesen , Urs Holzle, Type Feedback vs. Concrete Type Inference: A Comparison of Optimization Techniques for Object-Oriented Languages, University of California at Santa Barbara, Santa Barbara, CA, 1995](#)

APS93 [Ole Agesen , Jens Palsberg , Michael I. Schwartzbach, Type Inference of SELF, Proceedings of the 7th European Conference on Object-Oriented Programming, p.247-267, July 26-30, 1993](#)

CGZ94 [Brad Calder, Dirk Grunwald, and Benjamin Zorn. Quantifying Behavioral Differences Between C and C++ Programs. Journal of Programming Languages 4\(2\), Dec. 1994.](#)

 CUL89 [C. Chambers , D. Ungar , E. Lee, An efficient implementation of SELF a dynamically-typed object-oriented language based on prototypes, Conference proceedings on Object-oriented programming systems, languages and applications, p.49-70, October 02-06, 1989, New Orleans, Louisiana, United States \[doi>\[10.1145/74877.74884\]\(#\)\]](#)

 CU90 [Craig Chambers , David Ungar, Interactive type analysis and extended message splitting; optimizing dynamically-typed object-oriented programs, Proceedings of the ACM SIGPLAN 1990 conference on Programming language design and implementation, p.150-164, June 1990, White Plains, New York, United States \[doi>\[10.1145/93542.93562\]\(#\)\]](#)

DGC95 [Jeffrey Dean , David Grove , Craig Chambers, Optimization of Object-Oriented Programs Using Static Class Hierarchy Analysis, Proceedings of the 9th European Conference on Object-Oriented Programming, p.77-101, August 07-11, 1995](#)

 DS84 [L. Peter Deutsch , Allan M. Schiffman, Efficient implementation of the smalltalk-80 system, Proceedings of the 11th ACM SIGACT-SIGPLAN symposium on Principles of programming languages, p.297-302, January 15-18, 1984, Salt Lake City, Utah, United States \[doi>\[10.1145/800017.800542\]\(#\)\]](#)

Dyk77 [Eric J. Van Dyke. A dynamic incremental compiler for an interpretative language. HP Journal, p. 17-24, July 1977.](#)

 Gro95 [David Grove , Jeffrey Dean , Charles Garrett , Craig Chambers, Profile-guided receiver class prediction, Proceedings of the tenth annual conference on Object-oriented programming systems, languages, and applications, p.108-123, October 15-19, 1995, Austin, Texas, United States \[doi>\[10.1145/217838.217848\]\(#\)\]](#)

 GW78 [Leo J. Guibas , Douglas K. Wyatt, Compilation and delayed evaluation in APL, Proceedings of the 5th ACM SIGACT-SIGPLAN symposium on Principles of programming languages, p.1-8, January 23-25, 1978, Tucson, Arizona \[doi>\[10.1145/512760.512761\]\(#\)\]](#)

HCU91 [Urs Hözlé , Craig Chambers , David Ungar, Optimizing Dynamically-Typed Object-Oriented Languages With Polymorphic Inline Caches, Proceedings of the European Conference on Object-Oriented Programming, p.21-38, July 15-19, 1991](#)

Höl94 [Urs Hözlé. Adaptive Optimization in SELF: Reconciling High Performance with Exploratory Programming. Ph.D. Thesis, Department of Computer Science, Stanford University, Aug. 1994. \(Available from <http://www.cs.ucsb.edu/~urs/>\)](#)

 HU94a [Urs Hözlé , David Ungar, Optimizing dynamically-dispatched calls with run-time type](#)

feedback, Proceedings of the ACM SIGPLAN 1994 conference on Programming language design and implementation, p.326-336, June 20-24, 1994, Orlando, Florida, United States [doi>[10.1145/773473.178478](https://doi.org/10.1145/773473.178478)]

- ◆ HU94b Urs Hözle , David Ungar, A third-generation SELF implementation: reconciling responsiveness with performance, Proceedings of the ninth annual conference on Object-oriented programming systems, language, and applications, p.229-243, October 23-28, 1994, Portland, Oregon, United States [doi>[10.1145/191081.191116](https://doi.org/10.1145/191081.191116)]
- ◆ JGZ88 Ralph E. Johnson , Justin O. Graver , Laurance W. Zurawski, TS: an optimizing compiler for smalltalk, Conference proceedings on Object-oriented programming systems, languages and applications, p.18-26, September 25-30, 1988, San Diego, California, United States [doi>[10.1145/62084.62086](https://doi.org/10.1145/62084.62086)]
- ◆ Joh79 Ronald L. Johnston, The Dynamic Incremental Compiler of APL\3000, Proceedings of the international conference on APL: part 1, p.82-87, May 30-June 01, 1979, New York, New York, United States [doi>[10.1145/800136.804442](https://doi.org/10.1145/800136.804442)]
- Kra83 Glenn Krasner, Smalltalk-80: bits of history, words of advice, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1983
- Mit70 James George Mitchell, The design and construction of flexible and efficient interactive programming systems, 1970
- OPS92 Nicholas Oxhøj , Jens Palsberg , Michael I. Schwartzbach, Making Type Inference Practical, Proceedings of the European Conference on Object-Oriented Programming, p.329-349, June 29-July 03, 1992
- ◆ PS91 Jens Palsberg , Michael I. Schwartzbach, Object-oriented type inference, Conference proceedings on Object-oriented programming systems, languages, and applications, p.146-161, October 06-11, 1991, Phoenix, Arizona, United States [doi>[10.1145/118014.117965](https://doi.org/10.1145/118014.117965)]
- PR94 Hemant D. Pande and Barbara G. Ryder. Static Type Determination and Aliasing for C++. Technical Report LCSR- TR-236, Rutgers University, Dec. 1994.
- ◆ PC94a John Plevyak , Andrew A. Chien, Precise concrete type inference for object-oriented languages, Proceedings of the ninth annual conference on Object-oriented programming systems, language, and applications, p.324-340, October 23-28, 1994, Portland, Oregon, United States [doi>[10.1145/191081.191130](https://doi.org/10.1145/191081.191130)]
- PC94b John B. Plevyak and Andrew A. Chien. Precise Concrete Type Inference and Its Use in Program Optimization. Unpublished report, Oct. 1994.
- PC94c John B. Plevyak and Andrew A. Chien. Efficient cloning to eliminate dynamic dispatch in object-oriented languages. Unpublished report, Dec. 1994.
- ◆ PZC95 John Plevyak , Xingbin Zhang , Andrew A. Chien, Obtaining sequential efficiency for concurrent object-oriented languages, Proceedings of the 22nd ACM SIGPLAN-SIGACT symposium on Principles of programming languages, p.311-321, January 23-25, 1995, San Francisco, California, United States [doi>[10.1145/199448.199524](https://doi.org/10.1145/199448.199524)]
- ◆ Suz81 Norihisa Suzuki, Inferring types in Smalltalk, Proceedings of the 8th ACM SIGPLAN-SIGACT symposium on Principles of programming languages, p.187-199, January 26-28, 1981, Williamsburg, Virginia [doi>[10.1145/567532.567553](https://doi.org/10.1145/567532.567553)]
- ◆ US87 David Ungar , Randall B. Smith, Self: The power of simplicity, Conference proceedings on Object-oriented programming systems, languages and applications, p.227-242, October 04-08, 1987, Orlando, Florida, United States [doi>[10.1145/38765.38828](https://doi.org/10.1145/38765.38828)]

VHU92 [Jan Vitek , R. Nigel Horspool , James S. Uhl, Compile-Time Analysis of Object-Oriented Programs, Proceedings of the 4th International Conference on Compiler Construction, p.236-250, October 05-07, 1992](#)

↑ CITED BY 25

[Loren Larsen , Mary Jean Harrold, Slicing object-oriented software, Proceedings of the 18th international conference on Software engineering, p.495-505, March 25-29, 1996, Berlin, Germany](#)

- ◆ [Jeffrey Dean , Greg DeFouw , David Grove , Vassily Litvinov , Craig Chambers, Vortex: an optimizing compiler for object-oriented languages, ACM SIGPLAN Notices, v.31 n.10, p.83-100, Oct. 1996](#)
- ◆ [Urs Hözle , David Ungar, Reconciling responsiveness with performance in pure object-oriented languages, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.18 n.4, p.355-400, July 1996](#)
- ◆ [Rastislav Bodík , Rajiv Gupta , Mary Lou Soffa, Interprocedural conditional branch elimination, ACM SIGPLAN Notices, v.32 n.5, p.146-158, May 1997](#)
- ◆ [Erik Johansson , Sven-Olof Nyström, Profile-guided optimization across process boundaries, ACM SIGPLAN Notices, v.35 n.7, p.23-31, July 2000](#)
- [David Grove, The impact of interprocedural class analysis on optimization, Proceedings of the 1995 conference of the Centre for Advanced Studies on Collaborative research, p.25, November 07-09, 1995, Toronto, Ontario, Canada](#)
- ◆ [Amer Diwan , Kathryn S. McKinley , J. Eliot B. Moss, Using types to analyze and optimize object-oriented programs, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.23 n.1, p.30-72, Jan. 2001](#)
- ◆ [Suresh Jagannathan , Andrew Wright, Flow-directed inlining, ACM SIGPLAN Notices, v.31 n.5, p.193-205, May 1996](#)
- [Sara Porat , Bilha Mendelson , Irina Shapira, Sharpening global static analysis to cope with Java, Proceedings of the 1998 conference of the Centre for Advanced Studies on Collaborative research, p.19, November 30-December 03, 1998, Toronto, Ontario, Canada](#)
- ◆ [Andrew K. Wright , Suresh Jagannathan, Polymorphic splitting: an effective polyvariant flow analysis, ACM Transactions on Programming Languages and Systems \(TOPLAS\), v.20 n.1, p.166-207, Jan. 1998](#)
- ◆ [Ayal Zaks , Vitaly Feldman , Nava Aizikowitz, Sealed calls in Java packages, ACM SIGPLAN Notices, v.35 n.10, p.83-92, Oct. 2000](#)
- ◆ [Rastislav Bodík , Rajiv Gupta , Mary Lou Soffa, Load-reuse analysis: design and evaluation, ACM SIGPLAN Notices, v.34 n.5, p.64-76, May 1999](#)
- ◆ [Amer Diwan , J. Eliot B. Moss , Kathryn S. McKinley, Simple and effective analysis of statically-typed object-oriented programs, ACM SIGPLAN Notices, v.31 n.10, p.292-305, Oct. 1996](#)
- ◆ [Peter Lee , Mark Leone, Optimizing ML with run-time code generation, ACM SIGPLAN Notices, v.31 n.5, p.137-148, May 1996](#)
- ◆ [J. Michael Ashley, The effectiveness of flow analysis for inlining, ACM SIGPLAN Notices, v.32 n.8, p.99-111, Aug. 1997](#)

- ◆ David Grove , Jeffrey Dean , Charles Garrett , Craig Chambers, Profile-guided receiver class prediction, ACM SIGPLAN Notices, v.30 n.10, p.108-123, Oct. 17, 1995
- ◆ David F. Bacon , Peter F. Sweeney, Fast static analysis of C++ virtual function calls, ACM SIGPLAN Notices, v.31 n.10, p.324-341, Oct. 1996
- ◆ Olivier Zendra , Dominique Colnet , Suzanne Collin, Efficient dynamic dispatch without virtual function tables: the SmallEiffel compiler, ACM SIGPLAN Notices, v.32 n.10, p.125-141, Oct. 1997
- ◆ Takeshi Ogasawara , Hideaki Komatsu , Toshio Nakatani, A study of exception handling and its dynamic optimization in Java, ACM SIGPLAN Notices, v.36 n.11, p.83-95, 11/01/2001
- ◆ John Aycock, A brief history of just-in-time, ACM Computing Surveys (CSUR), v.35 n.2, p.97-113, June 2003
- ◆ Takeshi Ogasawara , Hideaki Komatsu , Toshio Nakatani, EDO: Exception-directed optimization in java, ACM Transactions on Programming Languages and Systems (TOPLAS), v.28 n.1, p.70-105, January 2006
- Peter F. Sweeney , Michael Burke, Quantifying and evaluating the space overhead for alternative C++ memory layouts, Software—Practice & Experience, v.33 n.7, p.595-636, June 2003
- ◆ Kazuaki Ishizaki , Motohiro Kawahito , Toshiaki Yasue , Hideaki Komatsu , Toshio Nakatani, A study of devirtualization techniques for a Java Just-In-Time compiler, ACM SIGPLAN Notices, v.35 n.10, p.294-310, Oct. 2000
- ◆ Peter Lee , Mark Leone, Optimizing ML with run-time code generation, ACM SIGPLAN Notices, v.39 n.4, April 2004

#### ↑ INDEX TERMS

**Primary Classification:**

- K. Computing Milieux**
  - ↪ **K.6 MANAGEMENT OF COMPUTING AND INFORMATION SYSTEMS**
    - ↪ **K.6.2 Installation Management**
      - ↪ **Subjects:** Benchmarks

**Additional Classification:**

- D. Software**
  - ↪ **D.3 PROGRAMMING LANGUAGES**
    - ↪ **D.3.2 Language Classifications**
      - ↪ **Subjects:** Object-oriented languages
    - ↪ **D.3.4 Processors**
      - ↪ **Subjects:** Optimization

**General Terms:**

Design, Languages, Measurement, Performance, Theory

#### ↑ Collaborative Colleagues:

Ole Agesen: David Detlefs	John C. Mitchell
David L. Detlefs	J. Eliot Moss

Christine H. Flood	Jens Palsberg
Stephen N. Freund	Y. S. Ramakrishna
Alex Garthwaite	Y.S. Ramakrishna
Alexander T. Garthwaite	Michael I. Schwartzbach
Urs Hözle	Nir N. Shavit
Urs Holzle	Guy L. Steele
Ross Knippel	David Ungar
Paul A. Martin	Derek White
Urs Hözle:	Ole Agesen
	Ralph Keller
	Gerald Aigner
	Chandra Krintz
	Jeff Bogda
	Raimondas Lencevicius
	John L. Bruno
	Ambuj K. Singh
	Brad Calder
	David Ungar
	Craig Chambers
	Jan Vitek
	Bay-Wei Chang
	Sylvia Dieckmann
	Karel Driesen
	Murat Karaorman

↑ Peer to Peer - Readers of this Article have also read:

- Data structures for quadtree approximation and compression **Communications of the ACM** 28, 9 Hanan Samet
- A hierarchical single-key-lock access control using the Chinese remainder theorem **Proceedings of the 1992 ACM/SIGAPP Symposium on Applied computing** Kim S. Lee , Huizhu Lu , D. D. Fisher
- The GemStone object database management system **Communications of the ACM** 34, 10 Paul Butterworth , Allen Otis , Jacob Stein
- An intelligent component database for behavioral synthesis **Proceedings of the 27th ACM/IEEE conference on Design automation** Gwo-Dong Chen , Daniel D. Gajski
- Putting innovation to work: adoption strategies for multimedia communication systems **Communications of the ACM** 34, 12 Ellen Francik , Susan Ehrlich Rudman , Donna Cooper , Stephen Levine

↑ This Article has also been published in:

- Conference on Object Oriented Programming Systems Languages and Applications **Proceedings of the tenth annual conference on Object-oriented programming systems, languages, and applications** 1995 , Austin, Texas, United States

The ACM Portal is published by the Association for Computing Machinery. Copyright © 2007 ACM, Inc.  
[Terms of Usage](#) [Privacy Policy](#) [Code of Ethics](#) [Contact Us](#)

Useful downloads:  [Adobe Acrobat](#)  [QuickTime](#)  [Windows Media Player](#)  [Real Player](#)